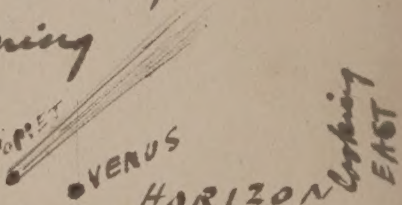
COMETS
THEIR ORIGIN, NATURE AND HISTORY

ELSON

10 May 1910

Had fine view of Halleys
Comet 3.30 am today
Had John Scharley see it.
Henry had seen it few days
ago his father
[illegible] his was 4 years old when it-
appeared in 1835.
May. father may see it
this morning



Sun below horizon
not risen yet

Venus directly in EAST

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A Comet in the Middle Ages.

COMETS

THEIR ORIGIN, NATURE AND HISTORY

BY

HENRY W. ELSON

Author of "Star-Gazer's Hand Book," "Side Lights on American History," etc., etc.

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TABLE OF CONTENTS

CHAP.		PAGE
I.	THE SOLAR SYSTEM AND THE STARS	
	Copernicus and Newton	3
	The Planets	5
	The Sidereal Heavens	8
II.	COMETS AND THEIR ORBITS	
	Nature of Comets	11
	The Orbits of Comets	13
III.	SUPERSTITIONS ABOUT COMETS	
	Astrology and Astronomy	18
	Ancient Beliefs	19
	Mediæval and Modern Superstitions	21
IV.	SOME REMARKABLE COMETS	
	The Great Comet of 1680	26
	Encke's Comet	28
	The Lost Biela's Comet	30
	Great Comets of the 19th Century	32
V.	METEORS AND SHOOTING STARS	
	Meteorites	36
	Why Meteors Fuse in the Air	39
	Meteoric Showers	41
VI.	HALLEY'S COMET	
	Halley's Calculations	46
	History of Halley's Comet	48
	The Coming in 1910	52

COMETS

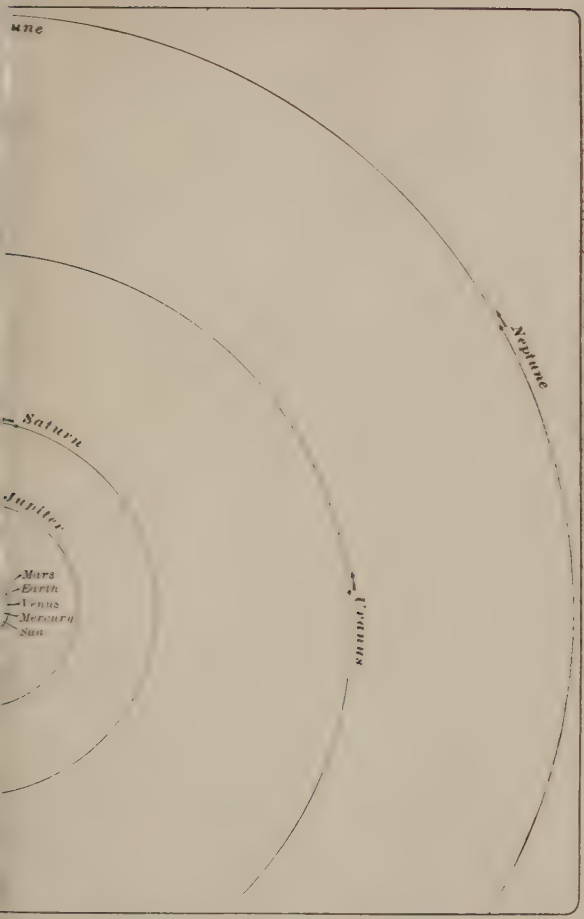
from a tree. Why did the apple fall to the ground? Why not in some other direction when loosened from the branch on which it grew? Newton concluded that there must be some attractive power in the earth itself that causes it to draw a loose body toward it. What could it be? It occurred to Newton that the attractive power was merely the earth's bigness, and he was right.

Here was a marvelous discovery. It accounted for the fact that loose bodies on the earth do not fall away from it, and it accounted for weight. Weight is therefore nothing else than the attractive power of one body for another. And Newton was right in concluding that all bodies of all sizes attract one another in a certain ratio according to their size and their distance apart. The farther two bodies are apart the less the attraction. If a rock weighing a ton were to be taken up from the earth into space it would grow lighter and lighter until it ceased to have any weight.

This great law was applied to the heavenly bodies. It is the attractive power of the sun that holds the planets from flying away into space.

The sun is a vast ball of fire in the sky thirteen hundred thousand times as large as the earth and nearly ninety-three million miles

THE SOL
Showing the Relative Distan



SYSTEM.

of the Planets from the Sun.

away. It is the light and heat of the sun that makes animal and vegetable life possible on the earth. Little wonder that the sun has been an object of worship by man in his primitive state.

The Planets

Around the sun eight worlds are speeding in sublime revolutions, at unlike distances and velocities.[1] There are also many small ones. All are kept from flying away into space by the sun's powerful attraction and from falling into the sun by the speed at which they are going. Tie a string to a ball and hurl it round your finger. The string keeps the ball from flying away, as the sun's attraction holds the earth; while the rapid movement of the ball keeps it from falling to your hand, as the movement of the earth round the sun keeps it from falling into the sun.

The earth flies round the sun at the rate of 19 miles a second, making a revolution in one year. It is this that causes the changes of the seasons. If the earth flew at the rate of 26 miles a second its speed would be so great as to over-

[1] For a table of the planets, their size, distance from the sun, time of revolution, etc., see Elson's Star-Gazer's Handbook, p. 14.

come the sun's gravitation and it would fly away into the unknown regions of space.

The earth is third among the eight large planets in distance from the sun. The nearest of the planets to the sun is Mercury, thirty-six million miles; Venus is second, sixty-seven million miles; and the earth third, about ninety-three million miles. The path of the earth round the sun, called its orbit, is not exactly a circle; it is an ellipse, and the earth is about three million miles nearer the sun in December than in June. When the earth is nearest the sun its speed is greater; as in the case of the ball and string, if you let the string wind round your finger the ball flies faster as the string grows shorter. From the same cause the planets nearest the sun fly faster through space than the remoter ones. If they did not they would fall into the sun. If the remote planets moved as fast as the near ones, they would break away from the sun and be lost in space. The speed of each planet exactly suits its distance from the sun and all move on and on forever in grand and marvelous harmony.

Outside the earth's orbit the next planet is Mars, as you will notice in the diagram. Mars is the only planet except our own that is supposed to be inhabited. Venus is about the size of the earth, but Mars is considerably smaller.

Beyond the orbit of Mars we find Jupiter, known as the giant planet. It is as large as 1,200 worlds like ours and is about 480,000,000 miles from the sun. It makes a revolution around the sun in twelve years. Jupiter cannot be the home of life because, as astronomers generally agree, it is not quite cold. The farthest of the planets is Neptune, nearly three billion miles away. It requires 165 years for this vast globe to revolve around the sun.

Probably all the planets millions of years ago were balls of fire like the sun; but now they are all dark, cold bodies, or at least have lost so much of their heat as to be no longer self-luminous. When we see them in the sky they look bright like stars because the sun shines on them. If they were not lightened by the sun they would be invisible to us, and the same is true of the moon. If there were inhabitants on the planets the earth would look to them like a bright star in the sky.

Where the planets came from, how long they have swung through space as they do now, what was the purpose of their creation, are facts that are utterly beyond human knowledge.

The planets all move round the sun in the same direction, from west to east. They are all contained within a narrow belt, sixteen degrees in width, called the zodiac. The sun and moon

also are always within the zodiac. In the latitude of the United States the zodiac is always between the zenith and the southern horizon. Neither the sun, the moon nor any of the planets can ever be seen in our latitude north of the zenith or in the southern horizon.

The Sidereal Heavens

Look up into the sky on a clear night and you behold two thousand or more sparkling orbs that look like jewels set in the grand overarching canopy. Three or four of these are probably planets, for a few of the planets are visible every clear night in the year. All the others are suns similar to our own sun. Many of them are inconceivably vast in size, probably a thousand times larger than our sun. They look very small only because of their distance from us. The distances of the nearest of the stars are vast beyond human conception.

Let us take an illustration to give an idea of the stupendous distance of the stars. The solar system, that is, the orbit of Neptune, is nearly six billion miles in diameter. Suppose we compress the solar system into a circle ten feet in diameter, which can be made on the floor of an ordinary room. On this scale the sun in the center would be the size of a small shot one-

fiftieth of an inch in diameter, and the earth would be a dot scarcely visible without a microscope. On this same scale the nearest of the fixed stars would be about eight miles away!

The stars seem to us to be fixed in a plane and about the same distance from us; but they are doubtless as far from one another as they are from us. The nearest one that has been measured is twenty-five trillions of miles from us in the measureless depths of space, and some have been measured that are nearly forty times as far away. They may all have systems of worlds revolving round them but the distance is so vast that these are not visible even through the most powerful telescope. We speak of the stars as fixed because they occupy the same relative position in the sky year after year and century after century. But they are not fixed; they are moving through space with incredible velocity. And the same is true of our sun, which, with all its family of planets, is moving at the rate of about twelve miles a second.

To sum up, our earth is one of eight large planets and many small ones that speed forever in sublime revolutions round the sun. They are kept from flying away into space by the sun's power of gravitation and from falling into the sun by the centrifugal tendency of their own motion. The sun and his retinue of

planets constitute the solar system. The twinkling stars that we see in the celestial vault are all mighty suns, and each may be the center of a system of revolving planets. So far away are the stars that the human mind has no power to comprehend the stupendous distance that separates the nearest of them from our system.

CHAPTER II

COMETS AND THEIR ORBITS

The sun, moon, stars, and planets are probably composed of the same kind of matter that makes up our earth; that is, rock, earth, mineral and the like. These elements may be in a white-hot molten state, as in the case of the sun and stars; or they may be in a solid state, as the crust of the earth, and of the planets.

It is well known that any substance may be reduced to vapor by very great heat, and the sun is partly vapor. Comets, the subject of the present chapter, are chiefly composed of matter in a state of vapor, and in some cases no doubt, entirely so.

Nature of Comets

A comet is usually composed of three parts, the nucleus, the coma, and the tail. The nucleus is the bright center which resembles a star in appearance. This nucleus may be composed of solid substance. It is very small in comparison with the major planets. Astrono-

mers have surmised that the nucleus of an average comet may not be more than one hundred miles in diameter, but it is exceedingly difficult to measure them. The mass of a heavenly body is measured chiefly by its attractive power on other bodies, but as a comet is too small to affect the orbits of other bodies, its mass is very difficult to ascertain.

The coma, is the luminous hood-like envelope by which the nucleus is covered. The word coma is from a Greek word which means hair and from it we get the word comet, because a comet seemed to the ancients like a tuft of hair in the sky. It is quite certain that the coma is neither solid nor liquid; it is gaseous. The nucleus and the coma together constitute the head of the comet. The tail of the comet is a luminous gas which streams out from the coma sometimes for many millions of miles. In some cases it is a magnificent stream of light extending half across the visible sky. Sometimes it is divided into two or more such streams, all centering in the head. The substance of a comet's tail is very much thinner than the air we breathe. In 1861 the earth passed through a comet's tail with no ill effects to anyone. A great many small comets seen through the telescope are wholly without tails.

The Orbits of Comets

The planets, as we have noticed, have fixed orbits in which they make regular revolutions that do not vary from century to century. They never wander away from the sun beyond their known orbits, and astronomers can tell where they are at any time. Indeed, the precise place in the sky that a planet will occupy a hundred years and more in the future can be calculated and determined with almost perfect accuracy.

Comets, on the other hand, are very different in their motions. A comet will suddenly burst into view, will dash around the sun, and fly away into the unknown realms of space. Comets have been called the tramps of the solar system. For thousands of years it was believed that comets had no regular path in the heavens, no system in their motion, but now it is known that they travel in fixed orbits and these orbits differ from the orbit of a planet only in the fact that the latter is more nearly circular.

Here it is necessary to explain the ellipse. A circle, as everyone knows, is a round figure the center of which is the same distance from all points in the circumference. An ellipse is an elongated circle. If you take a flexible circle like a hoop and press or pull it on two opposite

sides, it becomes an ellipse. No longer is there a point in the center equidistant from all points in the circumference. There are two points called foci, neither of which is in the center, but each bears the same relation as the other to the circumference. The distance between the foci is called the eccentricity of the ellipse. If the circle is elongated but slightly, the eccentricity is small; if much, it is great. The orbits of the planets and comets which return again and again to the sun are all ellipses, and in every instance the sun is at one of the foci. The sole difference between the orbit of the comet and that of the planet is that in the latter case the eccentricity is slight and in the former it is great.

Let us now take a periodic comet and follow it through its course. We say "periodic" because many comets, to be noticed later, visit our system only once.

A comet is discovered through a great telescope far away in the azure vault of the sky. It looks like a tiny tuft of white hair among the stars. Within a few days after its discovery its motion can be discerned and ere long the nature of its orbit can be ascertained. It is approaching the sun and is drawn solely by the sun's attractive power. It may be seen for

many months, or even for a year, through the telescope before it becomes visible to the unaided eye. Meantime its speed is increasing every hour because the nearer its approach to the sun the greater his power of attraction.

At length our comet looms forth to the view of all, a wonderful spectacle, increasing nightly in brilliancy. It is the most conspicuous object in the night sky, and, if a large one, may even be seen in daytime. Still it approaches the sun and its motion has so increased that it whirls round that mighty orb with frightful velocity. Were it not for the increased velocity of the comet it would fly round and round the sun, drawing nearer and nearer until it would be swallowed up in that boiling cauldron and be seen no more.

But the highly accelerated movement of the comet increases its centrifugal force so greatly that it begins to pull away, and starts again on its long journey. Suppose its revolution requires a hundred years. It will then, when it pulls away from the sun, recede into space for fifty years, the sun all the time drawing back on it and retarding its flight, until at last the outward motion ceases and it returns again to the sun, repeating the same process we have described. It will be seen that the comet

whether coming or going, will move with far greater velocity when near the sun than when it is far out in space.

It is possible for a comet to strike the sun squarely instead of swinging round it, but such a contact has not taken place in historic times, far as we know. Should this occur the comet would be enveloped utterly and its identity lost. Were it a large body the impingement would greatly increase the sun's light and heat; but a comet is so small that the effect of such contact would scarcely be noticed on the earth.

Some comets have passed so near the sun as almost to graze his glowing surface and when such is the case the comet sometimes reaches the inconceivable velocity of a million miles an hour.

Many comets, as we have noticed, have regular elliptical orbits and they return at regular intervals, subject to the laws that we have described. But there are others that visit our system only once. Drawn by the sun from the skies, they pass around it and fly away into the boundless depths of space never to return. This occurrence depends wholly on the velocity. If a comet is moving faster than twenty-six miles a second when ninety-three million miles from the sun, its orbit is a parabola instead of an ellipse, and the sun has not sufficient power

to draw it back again. Some comets return after a journey of a thousand years or more. Astronomers can now calculate pretty accurately by the shape of its orbit when a comet will return.

Comets are acted on not only by the sun but also by the greater planets, and it sometimes happens that a comet which would otherwise visit our system but once is so retarded by the attraction of such great planets as Jupiter or Saturn that it becomes a permanent member of the solar system. Jupiter has thus caught no less than eighteen comets, and a few are ascribed to Saturn and to the other larger planets.

CHAPTER III

SUPERSTITIONS ABOUT COMETS

Astrology and Astronomy

What in ancient times was known as Astrology has in modern times become Astronomy. The two words are derived from the same source, astra, a star, and alike they deal with the heavenly bodies. But there is a great difference in their present meaning.

Astrology was made up of a little knowledge and a great deal of conjecture and superstition. Astronomy is an exact science, the superstition feature having been eliminated. Astrology taught that important happenings on earth were accompanied, if not caused, by portentous signs and wonders in the sky. It taught that the position of the stars, especially of the planets, at the time of one's birth determined one's career, and to this day in all languages are found such expressions as "thank my stars," "lucky star," and the like—relics of the ancient belief in astrology. Astronomy has cast aside all that and has given us a knowledge of the

wonderful facts and laws explained in the preceding chapters.

Ancient Beliefs

No other heavenly bodies had woven about them such a web of superstition as the comets. A comet was considered ominous of evil by the ancients—war, pestilence, the death of princes, famine, and other calamities—all these were supposed to be accompanied if not brought on by the appearance of comets in the sky. A few examples will be interesting.

One early writer goes as far back as the time of Methuselah, declaring that the aged patriarch's death was presaged by the appearance of a comet which coursed through the twelve signs of the zodiac. Whether he received his information from tradition, or merely drew on his imagination is not known. Certain it is, however, that no comet travels through the twelve signs of the zodiac.

A comet, in the time of Abraham, is said to have accompanied the destruction of the cities of the plain, Sodom and Gomorrah, and another when Moses led Israel through the Red Sea and Pharaoh's host was swallowed up by the waves.

One of the Roman Sibyline books refers to comets as indicating dire calamities on the

earth. Sometimes, however, a comet was looked upon as a divine omen of good fortune. When Augustus Cæsar began his reign in Rome, he pronounced a comet then in the sky an omen of promise to himself and his people; he also declared that it conveyed his departed uncle, the great Julius Cæsar, to a place among the demigods.

In 79 A. D. the Emperor Vespasian refused to be frightened by the appearance of a comet. "This hairy star," he declared, "does not concern me. It menaces rather the King of the Parthians, for he is hairy and I am bald." But the fact remains that Vespasian died soon afterward and the people believed more than ever in the evil omen of comets. An expedition of Timoleon to Sicily with an army was heralded by a "burning flame in the sky," which preceded the fleet and was looked upon as an omen of success, though by the enemy it must have seemed the opposite. Seneca, the famous writer, attributes the swallowing up of two towns in Achaia to the evil influences of a comet that was traversing the heavens at the time of the calamity, about 370 B. C. Pliny speaks of a "terrific star," one "not easily expiated."

Josephus tells us that at the time of the destruction of Jerusalem 69 A. D., a sword-shaped

comet hovered for many months over the doomed city. It was widely believed that the malicious influence of a comet was a manifestation of the anger of the gods and that human prayers might influence it. It was further believed that the shape of a comet had something to do with its purpose, for, as Pliny tells us, if it resembles a flute, it will have an unfavorable influence on music.

Mediaeval and Modern Superstitions

All through the middle ages it was believed by all classes that every pestilence, plague, or wonderful event was connected with signs in the heavens, especially with comets. At the time of the battle of Hastings, 1066, when William the Conqueror captured the British throne, there was a magnificent comet in the sky, which has since been proved to have been Halley's Comet, to which the last chapter of this book is devoted.

Another notable appearance of this same comet was in 1456, three years after the fall of Constantinople into the hands of the Turks, and at a time when the Turks were threatening to subdue all southeastern Europe. This mysterious, brilliant, blazing star with its trailing tail extending far across the sky filled Christian

Europe with dismay and superstitious dread. It was believed that the comet was in league with the forces of anti-Christ and that it presaged the fall of Europe and the triumph of the Turks. The pope of Rome ordered prayers to be said, and the common prayer of the time was, "Lord, deliver us from the devil, the Turk and the comet."

Perhaps no comet ever inspired more dismay than a brilliant one that flamed across the sky in 1528. Ambroise Pare, the great French surgeon and father of French surgery, speaks of it thus: "This comet was so horrible, so frightful, and it produced such great terror in the vulgar, that some died of fear and others fell sick. It appeared to be of excessive length, and was of the color of blood. At the summit of it was seen the figure of a bent arm, holding in its hand a great sword, as if about to strike. At the end of the point were three stars. On both sides of the rays of this comet were seen a great number of axes, knives, blood-colored swords, among which were a great number of hideous human faces, with beards and bristling hair."

We may suppose that the most of these things existed only in the excited imagination of the people.

In 1664, a great rebellion in Ceylon was preceded by a blazing comet, the tail of which pointed to the west, the part of the country from which the rebellion sprung. While the rebellion was at its height the comet was overhead and it vanished when the uprising was put down. Of course the people believed the two to be most intimately connected.

There is at least one known instance in which the death of a royal personage and the appearance of a comet were closely related. It is said that Louise of Savoy, mother of Francis I, King of France, was one evening lying on her couch when she saw a comet through her window. Instantly she concluded that it was a sign foretelling her death, though she was not seriously ill. She took to her bed and nothing could induce her to rise again. Her physician attempted to convince her that she was in no danger but she would listen to nothing, and three days later she died.

A similar incident is recorded about Queen Elizabeth of England, but with different results. While holding court one night a comet was seen through the window. Her courtiers quickly closed the blinds in the fear perhaps, that she might be affected as Queen Louise had been; but Elizabeth ordered the curtains to be

thrown open. Then she stood at the window, gazed at the celestial visitor, and repeated a religious sentiment.

The superstition about comets did not cease with the coming of the modern era, not even after it was discovered that comets fly in regular orbits and many of them return at stated times. Napoleon Bonaparte believed that his protecting genie was a comet that bedecked the night sky at the time of his birth.

As late as 1829, an English physician and scientist published a book in which he devoted forty pages to a catalogue of plagues and epidemics, nearly all of which had been accompanied by comets. In 1825 a great many horses and other domestic animals died in Egypt, and the fact was attributed to a comet that appeared at the time.

In 1853, just before the outbreak of the Crimean War, a Russian priest pointed out to his flock a comet which he declared was the same that had guided the wise men of the east when they were searching for the new-born Savior. Its reappearance, he declared, was a signal for the Russian eagle to spread its wings and embrace all mankind in one faith.

Among the American Indians comets gave rise to superstitions similar to those of the rest of the world. Here is one example: The Inca,

a South American tribe, beheld two comets at the same time and they imagined that one resembled a lion and the other a serpent. They believed these messengers had come to destroy the moon and that if the moon were destroyed all men would be changed into hideous monsters. In the hope of averting this calamity, they shot arrows and threw stones at the comets.

CHAPTER IV

SOME REMARKABLE COMETS

The most interesting of all comets is the one known as Halley's Comet, which we reserve for a separate chapter. In this chapter we shall notice a few of the famous comets that have attracted wide attention in the astronomic world. Usually an important comet is given the name of its discoverer, but the man who made a life study of these heavenly messengers and who made a remarkable discovery about them, never had one called after his name. This was Sir Isaac Newton and the discovery he made was that comets are drawn from the depths of space by the sun's power of gravitation and that they move in regular fixed orbits.

The Great Comet of 1680

The comet known by the above caption, The Great Comet of 1680, might properly have been called Newton's Comet, because it was on this one that he made a special study and discovered the facts above mentioned. This comet was a

Halley's Comet, 1835.

Donati's Triple-tailed Comet, 1858.

most brilliant one. Newton noticed that as it approached the sun its speed was wonderfully increased and it occurred to him that the accelerated motion was caused by the sun's power, and that it had come from afar, drawn by this power alone.

The discovery was soon accepted by other astronomers and, like the law of gravitation, is now accepted by all. Newton next came to the conclusion that this comet and probably all others moved in a fixed orbit and this discovery is also now accepted by astronomers the world over.

Another great discovery was made, or rather suspected, while a study was being made of the comet of 1680, namely, that many of the appearances of comets are but reappearances. That is, many comets come and go at regular intervals and so have continued for many thousands of years.

There was a young astronomer, named Edmund Halley who worked with Newton and who was the first to suspect that the comet of 1680 had visited our system before. From the shape of its orbit it was calculated that the period of this comet must be between 500 and 600 years. Halley traced back over the records of comets in the past (and it was a difficult thing to do, for the records were not very accurate in ancient

times), and found that in the year 1106 a great comet had appeared, another in the year 531, and still another in 44, before Christ—the year in which Julius Cæsar was killed. The descriptions of all these were about the same and Halley noticed that they had come at intervals of 575 years. He suspected therefore, that all these were the same comet—that of 1680. If he was right, this same comet will come again in 2255—more than 300 years in the future, and not till then will the world know whether the young astronomer was right in his conclusion or not. If he calculated correctly, that comet is now billions of miles away and is still moving from the sun, as it has been for 230 years. But its speed is ever decreasing and at last, about 50 years hence, its outward motion will cease and it will return to the solar system. The return journey will require the same time as the outward journey—nearly 300 years.

Encke's Comet

The comet known by this name is notable as the first comet known to have a short period. About 1818, Professor Encke, the Great German astronomer, began studying the orbit of a comet that was supposed to have appeared several times in the preceding quarter century. He

found by the shape of its orbit that its period was three and a half years, and it has since been called by his name, Encke's comet.

For many years thereafter Prof. Encke observed the periodic returns of this comet and he discovered the remarkable fact that its period was shortened at each successive return by about two hours and a half. To account for this he came to the conclusion that there must be a resisting medium in space by which the comet is retarded.

The air as we know is a resisting medium. A cannon ball shot in a horizontal direction at a certain height would go on and on forever around the earth and never fall to the ground if it were not for the resistance of the air. Water has a still greater resisting power. But above the earth a hundred miles or more, where there is no air, there is supposed to be nothing to retard the speed of any body that is moving.

Encke believed, however, that he had discovered a resisting medium in space, very much thinner than the air of course, but dense enough to retard the course of so light a body as a comet. But the scientists have not accepted Encke's theory and it is now believed that universal space is filled by nothing but ether, which has no power to retard a moving body. Encke's comet therefore must be retarded by some other

agency, possibly by the attraction of the planets. If the comet continues to lose in its course, it will describe a smaller and smaller circle, or ellipse, and sometime, thousands of years in the future, it will fall into the sun.

The Lost Biela's Comet

It sometimes happens that a comet passes so near the sun that it is torn to pieces by his tremendous power of gravitation. The fragments then continue in their flight round the sun in the same orbit as before. Among these the most remarkable is that known as the lost Biela's comet. Biela was an Austrian soldier who devoted his leisure hours to astronomy. In 1826 he discovered the comet that bears his name, or rather, that bore his name as long as it existed.

Biela found that his comet had a period of a little more than six and a half years. When this comet appeared in 1845 a strange thing happened. It divided into two distinct parts, each appearing like a separate comet. These parts seemed to be about 200,000 miles apart when they ceased to be visible in their journey away from the sun.

It was with the greatest interest that astronomers watched for the return in 1852. At length

the two parts came in range of the telescope and it was found that they had separated still more and were now about a million and a half miles apart. Still again, six and a half years later, the astronomers watched, but they watched in vain. Biela's comet has never been seen since 1852. It is believed that the comet disintegrated entirely and that the fragments still continue in the same path occupied by the comet before its disintegration. This belief is confirmed by the fact that at every time when Biela's comet should appear the earth passes through a shower of meteors, or shooting stars, as they are often called. These are called Bielids, from the name of the comet and its discoverer. At the time of one of these showers, in 1885, a large iron meteorite fell at Mazapil, Mexico, and there is no doubt that it once formed a part of Biela's comet. But we must reserve the subject of meteors for a separate chapter.

One thing more must be mentioned before leaving this subject. It was in connection with Biela's comet that astronomers predicted the possibility of its striking the earth, and great alarm was felt by the people in many parts of the world.

Two questions here arise: Is it possible for a comet to strike the earth? Should one do so,

what would be the result? To the first question the answer is, yes, it is possible, but not probable. If two men with rifles were to stand, say 200 yards apart, and shoot into the air so that the bullets would cross each other's path, how often would they have to fire until their bullets would strike each other in the air? Such a thing might not occur in a million shots.

A comet crosses the earth's orbit, but it is scarcely more probable that it will hit the earth than that one rifleman's bullet will hit that of the other. It has been estimated that the chances are that a comet will strike the earth once in fifteen million years.

As to the other question, it is well known that the earth may pass through a comet's tail with no ill effects, and this has been known to occur. But if the head of a large comet were to strike the earth squarely, it would probably generate great heat and destroy all life for hundreds of miles around. But it is not at all likely that the earth would be rendered uninhabitable, as would certainly be the case if a large planet should come in contact with the earth.

Great Comets of the 19th Century

The Nineteenth Century is noted for some of the most wonderful comets ever seen, in addition

to those already mentioned. One of the finest of the century appeared in 1811. The period of its sublime revolution through space was computed to be about 3,000 years. Its last appearance must have been about the time of the Trojan War, and before Rome was founded or David was King of Israel. On its outward journey it will speed for ages and ages and when it returns again our times will be ancient times and nearly a hundred generations of men, yet unborn, will have come and gone.

The great comet of 1843 is pronounced by some astronomers the most remarkable of all known comets. It was wonderfully brilliant and was visible during the day as well as at night. It appeared suddenly in February, approaching the sun with frightful velocity. For a time it was thought that it would strike the sun, but it swung round his glowing surface, less than 50,000 miles away—the nearest approach to the sun of all known bodies. When nearest the sun this comet was traveling with the incredible speed of a million miles an hour. It will come again in something over 500 years.

The brilliant comet that appeared in 1858 is known as Donati's comet. It was first discovered in June of that year by Donati, a noted astronomer of Florence, Italy. A few weeks later it was discovered independently by three

American observers. At first it could be seen only through the telescope and no tail was visible. Early in the fall it developed with wonderful rapidity and hung in the western sky all through the autumn months, a sublime and beautiful object. Its period was computed at 2,000 years. Its last appearance was probably about a century before the birth of Christ.

Another comet, almost if not fully equal to Donati's appeared in 1861. This one is especially remarkable for the fact that the earth was enveloped in its tail to a depth of 300,000 miles. The effect was not noticeable except for a faint glow in the atmosphere.

The next great comet appeared in 1874 and is known as Coggia's comet. It was discovered near the North star by Coggia, a Frenchman. Its tail extended nearly half across the sky.

Finally, three comets appeared in three successive years, 1880, 1881 and 1882. The first of these was visible only in the southern hemisphere. The second was a fine comet, but it was the third that especially attracted the world's attention.

This is known as the Great Comet of 1882. Early in September, it was first seen by observers at the cape of Good Hope, in Australia, and in South America. This was the most brilliant comet since 1843; it was visible for

nine months and its tail was two hundred million miles in length. It was one of the few comets in history that have been visible in day time. This comet was seen to pass over the sun's disk by observers in South Africa, a thing unknown before in the history of astronomy and that can hardly be expected again in hundreds of years. When the head of the comet was directly between the observer and the sun it ceased to be visible even through the telescope. This fact proved that if the comet was composed of solid matter, it was too small to be seen. No very notable comets appeared between 1882 and 1910, though scarcely a year ever passes without a few are visible through the telescope.

CHAPTER V

METEORS AND SHOOTING STARS

On a clear night one can scarcely watch the sky an hour without seeing what is called a shooting star. But in fact it is not a star at all, nor is it a hundred millionth part as far away as the nearest of the stars.

Meteorites

When a shooting star or meteor falls to the ground, it is called a meteorite, or sometimes an aerolite, which means an air-stone. Very few indeed of the number that may be seen flashing through the air ever reach the ground. So rarely have they been seen to fall that for many centuries the scientists and wise men refused to believe the stories of people that saw them. Not more than a hundred years ago all such stories were considered fabulous. None but the ignorant and illiterate had ever seen a meteorite fall, said the wiseacres. And often they had reason to take such a position.

Here is an example: A Hindoo saw a meteorite fall in the jungles of India. There was

the fresh hole it had made in the ground and there was the stone; but the man had been so frightened that when questioned about it he declared that the stone had pursued him for some time through the jungle before it fell to the ground. This led his questioners to doubt the whole story.

No one now doubts what the common people asserted for thousands of years—that stone and iron sometimes fall from the sky; and this is not the only instance where the scientists are led and not followed by popular belief.

A few examples will here be interesting. Since it has been accepted as a fact that meteorites do sometimes fall, many records of the past, though long doubted, are now regarded as true. Livy, the Latin historian, informs us that about 654 B. C. a shower of stones fell on Alban Mount, near Rome.

In the year 1492, a stone weighing 260 pounds fell at Ensisheim, in Alsace, with a loud noise like thunder. It was considered a miraculous event and the stone, by order of Emperor Maximilian, was suspended in the church, where it hung for 300 years, an object of adoration by the people.

On April 20, 1876, the village of Shropshire, England, heard a strange rumbling noise in the air followed by a terrific explosion. An hour

later a farmer saw a fresh-made hole in the ground in one of his fields. In this was found a stone, partly iron, still warm, weighing about eight pounds. It was taken to the British museum where it may be seen by anyone.

One of the most wonderful showers of meteorites on record took place in Iowa on May 10, 1879. The heaviest of the stones that fell weighed 437 pounds. A meteorite in the Amherst collection, which fell in Colorado, is of exactly the same weight. There is one in the Yale collection, which fell in Texas, that weighs 1635 pounds.

Meteoric stones and iron are so unlike those on the earth that it is easy to detect them even if they are not seen to fall. But analysis shows that they do not contain any elements that are not already on the earth. Iron meteorites have also small amounts of cobalt, tin, copper and other substances, though none of the precious metals as gold, silver and platinum.

The origin of meteorites is unknown. Some conjecture that they were probably thrown from the moon or the planets by volcanic action in remote times and that they revolved about the sun until caught in the earth's atmosphere. Others think they are parts of broken comets, as meteors are supposed to be; but no one pretends to say what was the origin of the comets.

Why Meteors Fuse in Air

As we have stated, only a very small portion of the meteors ever reach the ground. We see a brilliant streak of light across the sky and in a few seconds it is gone. What becomes of the object that caused it? The fact is, it is reduced to vapor by its swift passage through the air.

It is believed by astronomers that space is occupied by not only stars or suns, with their trains of planets whirling around them, but that there are also countless millions of bodies, too small for the telescope, that move around the sun just as the planets or comets do, and with equal velocity. The earth in its course around the sun constantly comes in contact with these small bodies, just as a ball thrown into the air filled with dust will strike many particles of dust. It is further believed that vast numbers of these bodies are encountered by the earth every day and that were it not for the protecting mantle of the air, all life on the earth would be destroyed.

How, it may be asked, can our atmosphere shield us, for instance, from a ball of iron flying directly toward us? Simply by its resisting power, and the heat that is generated thereby. A cannon ball is about ten degrees

hotter immediately after it has been shot from a cannon than before. The resistance of the air causes the rise in temperature. Remember now, that a meteor moves more than a hundred times as fast as a cannon ball. It travels through space at the rate of at least twenty miles a second. The earth is moving at nearly nineteen miles a second. If then the meteor strikes our atmosphere when coming in the opposite direction, its passage through it reaches the astonishing velocity of nearly forty miles a second. This is 3,000 times the speed of an express train. It would mean passing from New York to San Francisco in a minute and a quarter.

The result is that a meteor is raised to a white heat within a second or two after it strikes the air, though it was doubtless cold as ice before. The outside fuses and is brushed off by the air, leaving a luminous trail. In a few seconds the whole is reduced to vapor and nothing of it reaches the ground, except invisible dust. If this occurs at night and if you happen to be within sight of it and are looking in that direction, you see a "shooting star." Sometimes it is so brilliant as to light up the whole heavens. That may be because the meteor is large, perhaps weighing several tons.

On November 6, 1869, a wonderful spectacle

was seen in southern England. A fire-ball making a detonation exceeding the loudest thunder, was seen by thousands of people. It traversed 170 miles in five seconds, went out to sea at Cornwall, and fell into the water about twenty-seven miles from the land. It left behind it a luminous cloud about four miles wide which could be seen for nearly an hour. This was probably a meteor weighing several tons.

The great majority of these bodies which the earth picks up in its course are supposed to be very small; many of them may not be larger than shot or grains of sand, while others weigh several pounds or even tons. They perform their revolutions around the sun just as the mighty planets do and are governed by the same laws. Where they come from or how many thousands or millions of years they may have been flying through the boundlessness of space is utterly beyond our knowledge. Such knowledge belongs to the Almighty Creator.

Meteoric Showers

We have noticed isolated meteors or shooting stars, which fuse in the air and are reduced to vapor; also meteorites which fall to the ground. It may be said here that a meteorite,

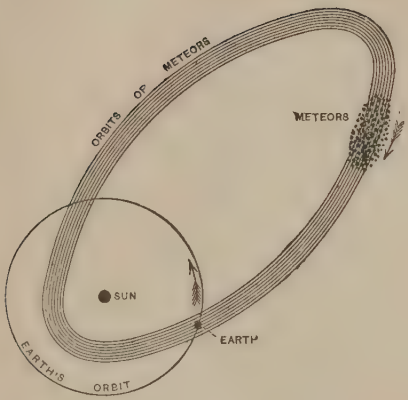
which is not fused in the air, but falls to the ground, does so because it overtakes the earth in its flight and does not meet the earth from the opposite direction. Its passage through the air is therefore by no means so rapid and this accounts for its not being fused by the resistance of the air.

It remains to notice here meteoric showers, many of which are recorded in history. Now and then the earth encounters shoals of meteors and hundreds or even thousands are seen in a night.

On the nights of November 13 and 14 every year a great many more meteors can be seen than at any other time of the year; and every thirty-third year these same November nights present a hundred times more meteors than in other years. Why all this?

It is well known that the earth at any moment occupies the same point in its path around the sun that it occupied the year before at the same moment. There must therefore be a place which it reaches on November 13, that is aswarm with meteors. But the meteors are traveling also quite as fast as the earth. How then does it happen that they are always to be found when the earth reaches that point?

Here is the explanation. There is a shoal of meteors coursing around the sun in an ellipse



A Shoal of Meteors Approaching the Earth's Orbit.

and its period of revolution is thirty-three and one-fourth years. This ellipse crosses the earth's path at the point where the earth is on the thirteenth of November each year. This shoal of meteors may be compared to a shoal of herrings in the ocean.

These meteors do not all move with equal speed and some are scattered all along the immense ellipse. This accounts for the fact that the earth meets some of them every November. But the great majority of them are in a bunch, not a compact bunch, but scattered over some millions of miles, so that it requires at least a year to cross the earth's path. If therefore those in advance should reach the earth's orbit in December, there would still be some to be encountered the following November. Hence, whenever this shoal crosses the earth's orbit—(every 33rd year) there is a wonderful shower of meteors. These meteors are called the Leonids, because they seem to emanate from a constellation in the sky called Leo.[1]

The Leonids have no doubt been traveling around the sun for many thousands of years; but the first authentic record of them dates back only to A. D. 902, which was called "the year of the stars." A Moorish king died that

[1] To find the constellations see Elson's Star Gazers' Handbook.

year and it was believed his death was commemorated by the star shower. Since that time there have been twenty-nine revolutions of the Leonids, but only twelve of them have been recorded. Very brilliant displays were seen in 1799, in 1833, and again in 1866. An old gentleman related to the writer that he was out driving on the night of the meteor shower in 1833. He declared that the shooting stars seemed thick as snow flakes and made a wonderful and beautiful display.

In 1899 the Leonids were due again, and astronomers waited eagerly for the display; but the number of meteors were fewer by far than on former occasions. Why this was true has not been explained. Some think that the meteors are becoming disintegrated and dissipated in space. But it is more probable that when the earth passed through the thickest of the shoal it was daylight, which would render them invisible.

It is supposed that the Leonids are the fragments of a shattered comet and in fact a comet which appeared in 1866, was found to have the same orbit as the Leonids. Whether this fact would indicate any relation between the two cannot be ascertained with certainty. If a comet is torn to pieces by its near approach to the sun, or from any cause, the pieces con-

tinue their flight as before. This is perhaps the origin of meteoric showers.

On the night of the tenth of August there are always to be seen a greater number of meteors than at ordinary times. These are called Perseids, because they radiate from the constellation Perseus. They also are known to follow the track of a former comet. There are various other periodic meteoric showers, but of less importance than the above-mentioned.

We have noticed that the comet called Biela's comet has ceased to make its periodic appearance; but there is always a shower of meteors at the time that it should cross the earth's orbit. This fact is the most conclusive proof that shoals of meteors are the fragments of shattered comets.

CHAPTER VI

HALLEY'S COMET

The most remarkable of all comets is that known as Halley's comet, not because it is more brilliant or larger than others, but because it was the first whose periodicity was determined. Since 1882 no very conspicuous comet has appeared in the sky; but the present year, 1910, will ever be remembered in astronomic circles for the reappearance of Halley's comet.

Halley's Calculations

Edmund Halley was a young astronomer, associated, as we have noticed, with Sir Isaac Newton. It was Halley who urged the great Newton to publish his manuscript setting forth the law of gravitation, and it was Halley who furnished the money for the printing, though he was by no means a rich man.

When Halley was contemplating the great comet of 1682 a great thought came to him. He noted that a comet similarly described and with a similar orbit had appeared in 1607, and

still another of the same kind in 1531. He observed that the period between these appearances was the same—nearly 76 years—and the thought occurred to him that perhaps these were reappearances of one and the same comet.

Basing his calculations on Newton's theory of gravitation and the elliptical form of cometary orbits, he began a series of laborious investigations. He spent years in calculating the great subject and finally he became convinced that he was right, that the three comets were identical. Twenty-two years after the appearance of the comet Halley came out with the bold prediction that this wonderful messenger of the sky would come again about the year 1758. He was then in his fiftieth year and he could have no hope of being among the living to witness the fulfillment of his prophecy, and he made the following modest statement:

"Wherefore, if it should return again about the year 1758, candid posterity will not refuse to acknowledge that this was first discovered by an Englishman."

Halley refused to give an exact date for the reappearance of the comet, because he knew that in its course it would pass near the giant planet Jupiter and his powerful attraction might retard its motion.

In later years, when the methods of calcula-

tion were improved, it was computed that the comet would probably be kept back 100 days by Saturn and 518 days by Jupiter, and that it would reach a point nearest the sun in the spring of 1759.

As the year 1758 approached, astronomers in all parts of the world scanned the heavens night after night. At last their vigilance was rewarded. The year was almost closed. It was on Christmas night, 1758, that a little tuft was descried through the telescope at the point in the sky where the long-looked-for comet was expected to appear. The prediction of Halley, who had long been in his grave, was verified, and the heavenly messenger was given his name, which it has since borne.

History of Halley's Comet

For many thousands of years, in a vast orbit 3,280,000,000 miles in length this wonderful heavenly body has been coursing through the sky, at a speed 50 times greater than the speed of a rifle bullet. Perhaps when the human race shall have run its course and disappeared from the earth this comet may still be making its sublime revolutions through interplanetary space and blazing forth upon the world every three quarters of a century.

Halley's comet is remarkable not only for its great size and brilliancy, and for the fact that it was the first whose return was successfully predicted, but also for its remarkable history. In European and Chinese history twenty-one appearances have been recorded. The first record which can be accepted with certainty was in the year 87 before Christ. Again it came in the year 11 B. C. In its next appearance, 66 A. D., it "hung over doomed Jerusalem" and was referred to by Josephus as "the sword of Jehovah." It struck terror to the hearts of the Jews, for many of them foresaw the destruction of their sacred city by the Roman armies a few years later.

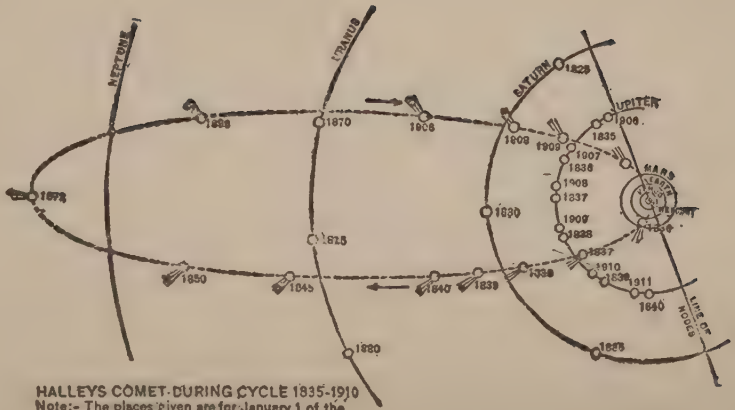
Some of the returns of Halley's comet were very notable indeed and one of these is supposed to have had a profound effect on the course of human history. This was in 1066, the year of the Norman conquest of England. The famous comet appeared that year. William the Conqueror believed it to be an omen of good fortune for him and his army, and they fought with the greater valor in the belief that they would win. On the other hand, King Harold looked upon the blazing comet as a presage of evil. His followers were disheartened. They lost the famous battle of Hastings; their valiant leader was slain and the Normans

became masters of England. The battle of Hastings changed the whole course of British history and greatly affected that of other nations. And who can say that the result was not due to some extent to the appearance of Halley's comet?

In the city hall at Bayeux, in Normandy, there is still preserved a long strip of tapestry, woven, it is said, by the hand of Matilda, wife and queen of William the Conqueror. One of the scenes on this tapestry, illustrating the conquest of England, is a curious representation of a group of people gazing out of a window at a blazing comet in the sky.

Many returns of this comet were not accompanied by important events, and are scarcely mentioned in the meager writings of the times. We have referred on the preceding page to the fright this comet gave Christian Europe in 1456, three years after the fall of Constantinople into the hands of the Turks, when it was feared that all Europe would fare as the Byzantine city had done.

One of the returns of Halley's comet is marked by the first permanent settlement of the first of the American colonies which became the United States—Jamestown in Virginia in 1607. The next return was that which Halley saw and from which he made his great discovery,



HALLEYS COMET DURING CYCLE 1835-1910
Note:- The places given are for January 1 of the dates indicated.

1682. And the next was the return that he predicted, 1758, which gave him undying fame. This return was marked by a very important historic event. It will be remembered that it was not seen even through the telescope until Christmas day, and that the following year, 1759, was the true year of its return, for it reached its greatest brilliancy in March. This year, 1759, was a great historic year in the New World. It marked the fall of Quebec and the expulsion of the French from the American continent.

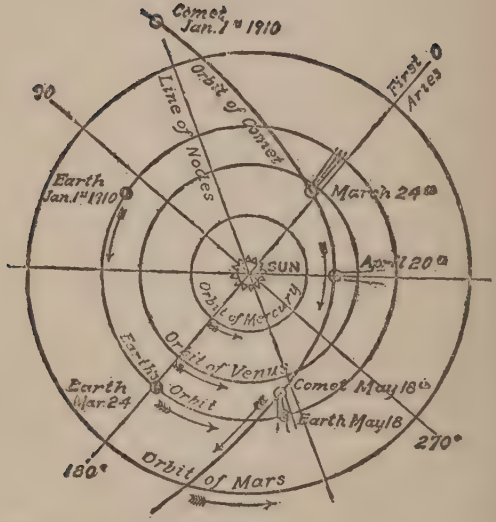
The next appearance of Halley's comet, and the last before the present year of 1910, was in 1835. This was but 75 years ago and there are people living to-day who remember the magnificent spectacle. And yet, as recent as it was, the superstitions of the past had not wholly faded away. Thousands of people believed that the end of the world was at hand. The Millerite belief, which taught this doctrine, had a great many followers in New York and other States in the East. The popular mind was greatly disturbed and hundreds of crops were allowed to rot in the fields on the theory that it was needless to save them when the last day was near at hand. This movement was not caused by the comet, but was fostered by it. By and by the comet sped away into the

sky and was lost to human vision, the world continued as before in its six hundred million mile revolution around the sun, the people recovered their normal condition and went to work again.

The Coming in 1910

The world has come to expect Halley's comet certainly and regularly at the stated time—a few months more than seventy-five years since the last appearance. For years astronomers have looked forward to 1910. The instruments of observation and measurement are far more perfect now than even when this comet last appeared. Exact measurements will be taken and hundreds of photographs—all of which will be recorded with the utmost accuracy for the use of future generations.

There is no uncertainty about this coming of Halley's comet in 1910. It has already been seen through many telescopes. The first to see it was Professor Max Wolff of Heidelberg, Germany, on the night of September 11, 1909. It was discovered at a point less than half a moon's width from the place where it was expected to appear, a filmy patch far away in the azure deep among the stars. At this writing (January, 1910) it has been seen from many observa-



Relative Positions of Halley's Comet, the Earth, and the Sun.— 1910.

tories, and in February it will appear to the naked eye.

By the middle of April it will have become a magnificent object, rushing toward the sun with marvelous velocity, with a streaming tail probably fifty million miles in length. Soon after this it will pass round the sun and then approach still nearer the earth, passing between it and the sun and probably not more than thirteen million miles from us. This will be a little later than the middle of May, and at that time the comet will be at its brightest and will probably be visible in daytime. In a few days thereafter it will begin to wane. It will fade away and at length will pass out of the range of the telescope. It will have gone again on its long journey, to a point beyond the orbit of Neptune, but will return about the year 1986.

Doubtless there are children who will see the comet this year and in tottering old age will see it again on its next return; but no man or woman can hope for such an experience.

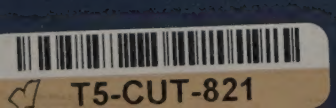
The superstition in connection with comets may be said to have disappeared in civilized lands; but the mysteries are as great as ever. What is the origin and destiny of this great comet? How many thousands or millions of years has it sped through space and how long

will it continue? Who can explain the nature of the laws that hold it in its course? What was the purpose of the Creator in flinging this marvelous object into space, to be seen now and then by wondering man?

Such elemental questions will rise in thoughtful minds; but for an answer from human wisdom we may listen in vain.

Every intelligent man or woman will be profoundly interested in the coming this year of this celestial wonder. It is true that only astronomers study it scientifically; but everyone will gaze upon it with reverential awe. What does it mean?—this transcendently glorious spectacle? Has it a message for me? It leads me nearer to nature's heart, leads me to contemplate the unfathomable universal mystery, of which I am a part. The man whose soul is not subdued with religious reverence at so grand a spectacle is less than a man. How wonderful, how mysterious the comet! But then it must be remembered that the ball on which we live is quite as wonderful and mysterious as the comet, and that the most wonderful thing on the earth is man.

THE END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